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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/GB87/00467 (22) International Filing Date: 3 July 1987 (03.07.87) (31) Priority Application Number: 8616214 (32) Priority Date: 3 July 1986 (03.07.86) (33) Priority Country: GB (71) Applicant (for all designated States except US): EXPLO-SIVE DEVELOPMENTS LIMITED (GB/GB): The Aerodrome, Melbourne, York SN13 0HX (GB). (72) Inventor; and (75) Inventor/Applicant (for US only): SHANN, Peter, Christian (GB/GB): Delwood Croft, Fenwicks Lane, Fulford, York YO1 4PL (GB). (74) Agent: OULTON, Richard, John: 22 Whitefriargate, Hull, North Humberside HU1 2EX (GB).	(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), LU (European patent), NL (European patent), NO, SE (European patent), SU, US. Published With international search report.	
FUEL COMPSN. INCLUDING FINELY-DIVIDED SOLID FUEL AND GUAR GUM + AS BINDER, GIVES CLEAN AND STABLE BRIQUETTES OR PELLETS, WITHOUT THE NEED TO DRY THE FUEL, AND BURNS CLEANLY		

(54) Title: IMPROVEMENTS IN OR RELATING TO FUELS

## (57) Abstract

New fuel in briquette, granular, pellet or the like processed form which offers great advantages over conventional processed fuels. The fuel comprises a combination of a single solid fuel, or a mixture of solid fuels, such as coal, coke or charcoal in divided form mixed with a binder comprising, or including, guar gum. Preferred combinations may include a cross-linking agent, such as titanium tetra chloride or zirconium and an acid, such as citric acid.

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"IMPROVEMENTS IN OR RELATING TO FUELS"

This invention relates to fuels and, more particularly, to solid fuels such as coal, coke, charcoal, wood and the like carbon based fuels in dust, powder, chip or other particulate form processed to form briquettes, pellets or granules.

Whilst certain specially designed furnaces can burn solid fuels in dust, powder, chip or other particulate form, hereinafter referred to as "divided" form, generally by spraying the divided solid fuel into the combustion chamber, most commercial and domestic furnaces, boilers, fires, and the like combustion devices cannot support or sustain combustion of fuels in such small divided form. Accordingly it has become the practise to process such solid fuels in divided form into briquettes, pellets, granules and the like processed forms, (hereinafter referred to as processed form).

Many carbon based fuels in divided form can be compressed into processed form by subjecting the divided fuel to high pressure and temperature but such processing is expensive and commercially viable only for very special applications.

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In more common processing the divided fuel, or a mixture of such fuels, is bound with a binder whereupon the combination can be formed into the desired processed form at lower temperatures and pressures. Generally the binder is an asphalt, coal or oil derivative, most commonly a derivative from coal or oil distillation, and the difficulties with such binders are that the divided fuel must be dried (such fuels normally have a high water content often exceeding 20% by weight), the binder on combustion generates smoke which contravenes most so called "smokeless zone" regulations, and the fuel is unsuited for many types of combustion devices.

To overcome the problems which arise from the use of such binders other binders have been proposed including, for example, cement and thermosetting resins. Difficulties with such binders reside on the fact that they are expensive, they add little, if any, calorific value to the processed fuel and they often degenerate in the combustion chamber causing unburned fuel to fall into the ash box where its value is lost.

A further difficulty with many known binders is that, when subjected to the high temperature of combustion of the fuel, they form, or give off, offensive and often dangerous gases and vapours.

The present invention seeks to provide a processed form for divided solid fuel which is capable of maintaining its processed form when exposed to the elements, is safe and inoffensive when subjected to combustion, which meets the smokeless zone requirements and which is commercially viable.

According to the present invention there is provided a combination, suitable for processing into a desired processed form, comprising a solid fuel, or a mixture of solid fuels, in divided form mixed with a binder, characterised in that the binder comprises, or includes, guar gum.

Preferably the guar gum comprises from 0.1% to 10% by weight of the combination of fuel and binder and, more preferably, from 0.5% to 5% by weight of the combination.

-3-

The present invention also envisages a fuel in processed form comprising a carbon based fuel, or mixture of such fuels, in divided form bound with a binder comprising or including guar gum.

Guar gum, hereinafter referred to as "guar", comprises the ground endosperm of the Indian plant *Cyanopsis tetragonoloba* and, as such, guar is a readily available and relatively cheap material. Many of the properties of guar are well known, in particular its ability to gel with water in the cold, and guar is used in foodstuffs but the peculiar properties which render this material ideal for use as a binder for solid fuel in divided form have never before been recognized, nor has this material been proposed for such use. Guar has the great advantages that it can be supplied to the divided fuel in the presence of water so that no expensive pre-drying of the divided fuel is required, the processed form of the fuel containing guar is very clean and stable and is not readily broken down when the processed form is exposed to the elements, during combustion the guar does not give off smoke or any noxious offensive gases, vapours or fumes and, during combustion, the binder retains the processed form until all the fuel has combusted. The recognition of the aforesaid advantages and the proposal to use guar as the, or part of the, binder in a processed form for divided solid fuel constitutes a major step in the art.

Preferably the combination includes a cross-linking agent, preferably a metal ion agent and, by way of example, titanium tetra chloride and zirconium have been found to be advantageous cross-linking agents for use with the combination proposed by the invention.

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-4-

The cross-linking agent may be added to the fuel before the guar is added, or after the guar has been added, but preferably the cross-linking agent is added to the fuel with the guar and in the presence of water.

Preferably the cross-linking agent comprises from 0.001% to 1% by weight of the guar in the combination but more preferably comprises from 0.005% to 0.02% by weight of the guar content combination.

When the combination of the divided fuel or fuels, the guar and the cross-linking agent produce an alkaline mixture the pH of the combination is preferably adjusted by adding an acid to the combination. Virtually any acid can be used but acids which do not produce noxious or offensive vapours or fumes when the processed form has been made or during combustion are preferred. Suitable acids are the fruit acids, preferably citric acid.

The invention will now be described further by way of the following examples.

Two solid coals, in finely divided form, were mixed in equal proportions and 1000g of the mixture was placed in a mechanical mixer. To the mixer was added 100g of water with 15g of guar and 0.01g of titanium tetra chloride intimately mixed therein together with a small amount of citric acid to adjust the pH of the combination. The combination was agitated for 3 minutes to obtain uniform distribution of the ingredients throughout the combination and the combination was then passed through a pelletizer to produce cylindrical pellets some 10mm in diameter and some 10mm long. The pelletized fuel combination hardened within 3 minutes of leaving the pelletizer and formed hard, clean, abrasive-resistant pellets which maintained their form without any observed breakdown when soaked in water for 3 minutes.

EXAMPLE 1

The pelletized fuel was allowed to stand and dry and was then placed in an open grate and ignited. The pellets were readily ignited and burned well, without giving off smoke or any offensive fumes or vapours, and the pellets retained their form throughout combustion.

After combustion the pellets were examined and the binder was observed to have carbonized, holding the ash of the combusted fuel, and all the fuel had burned so that combustion was complete. The combusted pellets in fact consisted of a light ash sinter which, with minimal disturbance, broke down to a sub-divided form.

EXAMPLE 2

Pelletized fuel made as described above, but with coke replacing the two coals, was burned without difficulty in a domestic gravity feed boiler.

EXAMPLE 3

Pelletized fuel made as described above, but substituting charcoal for the two solid coals, was burned on a barbeque, without ignition problems, smoke or fumes and without imparting any undesirable tastes or odours to food cooked thereon.

It is important to note that in the above examples the guar gum is mixed with water before being added to the fuel and this addition of water is of great advantages because if the water content of the divided fuel or fuels is monitored the amount of water added with the guar gum can be adjusted in direct relationship to the water content of the fuel and expensive drying of the solid fuel, essential in most conventional processing of fuels, can be avoided.

Whilst the combination in processed form proposed by the present invention is useful as a fuel and offers substantial advantages and benefits over conventional processed fuels the said combination does have other ancilliary uses and has, for example, been found to offer advantages in the metal industry, in particular the iron and steel industry, for introducing carbon into metals.



CLAIMS

1. In combination a solid fuel, or a mixture of solid fuels, in divided form mixed with a binder and processed to a desired process form, characterised in that the binder comprises or includes guar gum.
2. A combination as claimed in claim 1 characterised in that the guar gum comprises from 0.01% to 10% by weight of the combination of fuel and guar gum. ✓
3. A combination as claimed in claim 1 or 2 characterised in that the guar gum comprises from 0.5% to 3% by weight of the combination of fuel and guar gum. ✓
4. A combination as claimed in claim 1, 2, or 3 characterised in that the combination includes a cross-linking agent. ✓
5. A combination as claimed in claim 4 characterised in that the cross-linking agent comprises a metal ion agent.
6. A combination as claimed in claim 4 or 5 characterised in that the cross-linking agent comprises titanium tetra chloride.
7. A combination as claimed in claim 4 or 5 characterised in that the cross-linking agent comprises zirconium.
8. A combination as claimed in 4, 5, 6, or 7 characterised in that the cross-linking agent comprises from 0.00% to 1% by weight of the guar gum.
9. A combination as claimed in claim 8 characterised in that the cross-linking agent comprises from 0.00% to 0.02% by weight of the guar gum.
10. A combination as claimed in any preceding claim characterised in that the combination includes an acid.
11. A combination as claimed in claim 10 characterised in that the acid comprises a fruit acid.

WO 88/00232

PCT/GB87/00467

-8-

12. A combination as claimed in any preceding claim in which the said solid fuel comprises coal, coke or charcoal and the said mixture of solid fuels comprise combinations of coal, coke and/or charcoal.

13. A combination as claimed in any preceding claim in which the guar gum is mixed with water before being added to the fuel or fuels.

14. A combination as claimed in claim 13 in which the amount of water added with the guar gum is controlled in dependance upon the water content of the fuel or fuels.

## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/GB 87/00467

### I. CLASSIFICATION OF SUBJECT MATTER (Inventor's classification, if any, in addition to IPC)

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC<sup>1</sup>: C 10 L 5/14; C 10 L 5/10

### II. FIELDS SEARCHED

Minimum Documentation Searched \*

Classification System |

Classification Symbols

IPC<sup>4</sup>

C 10 L

Documentation Searched other than Minimum Documentation  
to the extent that such Documents are included in the Fields Searched \*

### III. DOCUMENTS CONSIDERED TO BE RELEVANT \*

Category *	Citation of Document, ** with indication, where appropriate, of the relevant passages **	Relevant to Claim No. **
A	FR, A, 867007 (DINTILHAC) 23 September 1941 see abstract; page 2, lines 24-40	1-3
A	FR, E, 29794 (GOUTAL et al.) 7 November 1925 see abstract, points 1-3; page 1, line 49 - page 2, line 17	1-11
A	US, A, 1376706 (KRATOCHWILL) 3 May 1921 see claims	1-3

\* Special categories of cited documents: 10

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"-" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date, but containing information which may be relevant to the applicant's invention, in particular the principle or the way of carrying out the invention

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### IV. CERTIFICATION

Date of the Actual Completion of the International Search

30th September 1987

International Searching Authority

EUROPEAN PATENT OFFICE

Date of Mailing of the International Search Report

26 OCT 1987

Signature of Authorized Person

M. VAN MOL



ANNEX TO THE INTERNATIONAL SEARCH REPORT ON  
-----INTERNATIONAL APPLICATION NO. PCT/GB 87/00467 (SA 17780)  
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This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 09/10/87

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Patent document cited in search report	Publication date	Patent family member(s)	Publicati date
FR-A- 867007		None	
FR-E- 29794		.None	
US-A- 1376706		None	